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A 'dark energy' wrenching apart our very universe

Research apparently provides confirmation

By Dennis Overbye
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Tuesday, July 22, 2003 - By comparing maps of heat emanating from the fading remnants of the Big Bang to maps of the modern universe, astronomers say they have uncovered evidence that some "dark energy" is wrenching the universe apart.

The new work, they said, provides independent confirmation of one of the strangest astronomical findings in recent years, that based on studies of distant exploding stars the expansion of the universe is speeding up.

The simplest explanation, astrophysicists say, is that space is imbued with a repulsive, or antigravitational, force first hypothesized in 1917 by Albert Einstein and known as the cosmological constant.

But nobody understands this so-called dark energy, although speculations have blossomed in the physics literature in the last few years.

Using the maps, a multinational team of 33 astrophysicists, led by Dr. Ryan Scranton of the University of Pittsburgh, found what the members called "the shadow of dark energy" in the form of a slight boost in the energy of the radiation from the Big Bang as it passed through huge clouds of galaxies.

The astronomers said their results represented an important validation of dark energy and the emerging consensus of a universe dominated by mysterious dark matter and even more mysterious dark energy, which is geometrically "flat," meaning that parallel lines drawn across the cosmos will not meet.

"This result is the piece of physical evidence that really closes the door," said Dr. Robert C. Nichol, an astrophysicist at Carnegie Mellon who said many physicists had taken a "wait-and-see" attitude about the dark energy acceleration.

An astronomer at the Space Telescope Science Institute in Baltimore, Dr. Adam Riess, said dark energy was becoming "the great cosmological detective story of today."

"If we can just keep collecting a few more clues about it," he added, "we might actually be able to figure out what the heck it is."

A paper describing the results has been posted at http://arxiv.org/list/astro-ph/new

The most recent results were obtained by combining data from the Sloan Digital Sky Survey, which is mapping the distances and positions of more than a million galaxies, with NASA's Wilkinson Microwave Anisotropy Probe. The probe, a satellite, is busy mapping the intensity of a faint cosmic microwave radiation that fills the sky and is presumed to represent heat emanating from the remains of the Big Bang when the universe was some 380,000 years old.

The cosmic radiation is rippled with hot and cool spots. Some of these are the result of lumps in the primodial cosmic gravy and are the seeds of galaxies and other conglomerations of matter. But other hot spots, theorists pointed out, may be generated by the microwaves' passage through the modern universe.

As a microwave passes through a large cloud of galaxies, its energy will first increase, as a rolling marble speeds up when it hits a dip in the road. Later, as the microwave leaves the cloud, gravity will take away some energy, as the marble climbs out of the dip.

In a universe that is geometrically "flat" with no dark energy, these effects will cancel out: No net change in the energy of the microwaves will occur.

But in an accelerating universe, the effects will not always cancel out. In the largest agglomerations of matter -- so-called superclusters still in the process of forming -- the microwaves will gain energy and thus appear hotter.

In such systems, tens of millions of light-years across, the force of dark energy trying to push the cloud apart is winning the battle over the gravity trying to pull the galaxies together. As a result the cloud gets less dense rather than more dense as the microwaves are going through it, explained Dr. Andrew J. Connolly, a team member from the University of Pittsburgh. And it takes less energy for them to climb back out than they acquired falling in.

Dr. Max Tegmark, a cosmologist at the University of Pennsylvania, compared the effect to racking up credit card debts during inflation.

"The payback is less than what is borrowed," Tegmark said.

So the microwaves should be slightly hotter, by a minuscule fraction of a degree.

The effect is known as the Integrated Sachs-Wolfe effect, after Dr. Arthur M. Wolfe, now at the University of California in San Diego, and Dr. Rainer K. Sachs, now at the University of California at Berkeley, who first investigated the effects of lumps in the universe on the cosmic microwaves back in 1967.

In recent months several groups, including those led by Dr. Stephen Boughn of Haverford College in Pennsylvania, Dr. Michael R. Nolta of Princeton and Dr. Pablo Fosalba of the Institute of Astrophysics in Paris have reported promising correlations between cosmic hot spots and sky catalogs of radio sources and X-rays, as well as galaxy maps. In an e-mail message referring the multinational team's findings, Fosalba, who used part of the Sloan data, said, "Despite the fact that we are using different galaxy samples, results from both analyses are in very good agreement and provide strong evidence for dark energy in the universe."

Scranton, also in an e-mail message, said his team's work was particularly important in validating the dark energy because it relied on sky survey data not available to other teams.